

Dependence of Mesoscale Coastal Predictability on Data Assimilation and Distribution of Observations

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LONG-TERM GOALS

The long term goal of this project is to determine the mesoscale atmospheric predictability and how it relates to synoptic scale uncertainty due to sampling and data assimilation of incomplete samples on the larger scale.

OBJECTIVES

The objectives of this research are to determine the ability to numerically predict mesoscale coastal structures in a variety of synoptic scale situations and demonstrate for given small scale structures the time ranges under which they might be considered predictable. The answer is probably dependent on the data assimilation system and one objective is to determine this sensitivity.

APPROACH

The basic approach is to run a series of numerical model experiments with slightly different observational samples and determine the relative spread in mesoscale forecasts. Since mesoscale truth is difficult to obtain from actual observations, we use a COAMPS model forecast as a representation of a true atmosphere. Samples are generated from this true atmosphere and then put into the data assimilation system for the MM5 model and subsequent forecasts are then verified against this truth. In this manner the impact of data sample, sample size, and data assimilation can be compared. This is being done for a variety of synoptic weather regimes to see if particular weather regimes have greater mesoscale predictability than others.

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WORK COMPLETED

The COAMPS model has been modified to allow initialization by either its standard multivariate optimum interpolation system (MVOI) or the multiquadric assimilation scheme developed by NPS. This modification has been done to allow the testing of data assimilation dependency of the predictability that was previously highlighted by Kuypers (2000). The system has been modified and tested on a sample data set and we are presently running experiments on two datasets. The first is a two week simulation during January 1999. . This simulated atmosphere was then used to sample observationally using an optimal sampling based on the 24 hour forecast valid at the analysis time. Multiquadric interpolation is used to iteratively determine the required points to define the structure of the 24 hour forecast. Then observations are extracted at these points and assimilated into the model using either MVOI or multiquadric techniques. The forecasts will be subsequently compared to compile statistics over the two week period of simulation to highlight the data assimilation dependency of the predictive error. A real data case is also being prepared from the Pacific Landfalling Jets Experiment (PACJET) conducted last winter. An explosive cyclone case off the southern California coast that was poorly predicted by the models is being used for these experiments.

RESULTS

Results are very preliminary as this work is not completely done. There do seem to be differences in the forecast error for the two data assimilation approaches. The magnitude of the differences based on only a few forecasts appear to be comparable to the range in predictive error produced by different data samples. RMS wind speed and precipitation differences (where appropriate) between the two forecasts initialized using different assimilation schemes can be as large as the basic forecast error in any given 24 hour forecasts. This suggests that there is substantial uncertainty in determining the initial state of the atmosphere for insertion into the model and that neither assimilation scheme examined to date eliminates this basic uncertainty. These uncertainties are being quantified for the complete data set and will be reported on in the future.

IMPACT/APPLICATION

The impact of these studies will be in furthering our understanding of the limits to mesoscale prediction using actual numerical models and data assimilation approaches. This will greatly aid Navy forecasters in knowing how best to use forecasts from mesoscale models.

TRANSITIONS

These results have been used as classroom examples at the Naval Postgraduate School.

RELATED PROJECTS

The ONR-sponsored project by the same investigators, entitled "Practical Limits to Atmospheric Mesoscale Predictability" is closely related and utilizes some of the same cases to examine the application of mesoscale predictability to routine forecasts.

SUMMARY

This research has demonstrated that numerical weather forecasts on small scales are very sensitive to small differences in the analyzed structure of the atmosphere used to make the forecast. This exact nature of this sensitivity and its dependence on the mathematical approach to start a numerical model will be determined in the ongoing research in coming years.

REFERENCES

Kuypers, M.A., 2000: Understanding mesoscale error growth and predictability. M.S. Thesis, Naval Postgraduate School, 114pp.